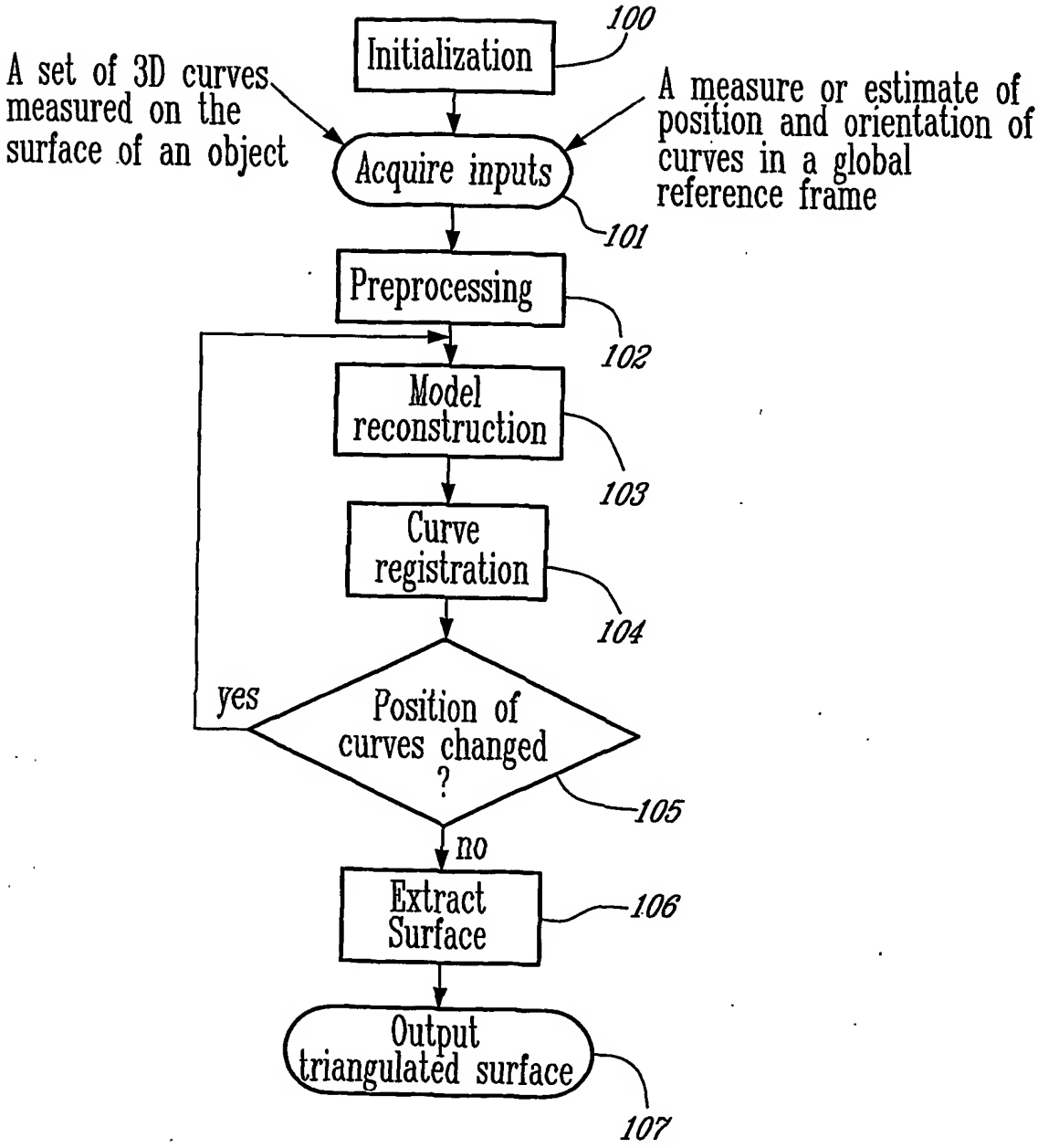
Initialization
100
A set of 3D curves measured on the surface of an object
A measure or estimate of position and orientation of curves in a global reference frame
Acquire inputs
101
Preprocessing
102
Model reconstruction
103
Curve registration
104
yes
Position of curves changed ?
105
no
Extract Surface
106
Output triangulated surface
107

Fig. 1

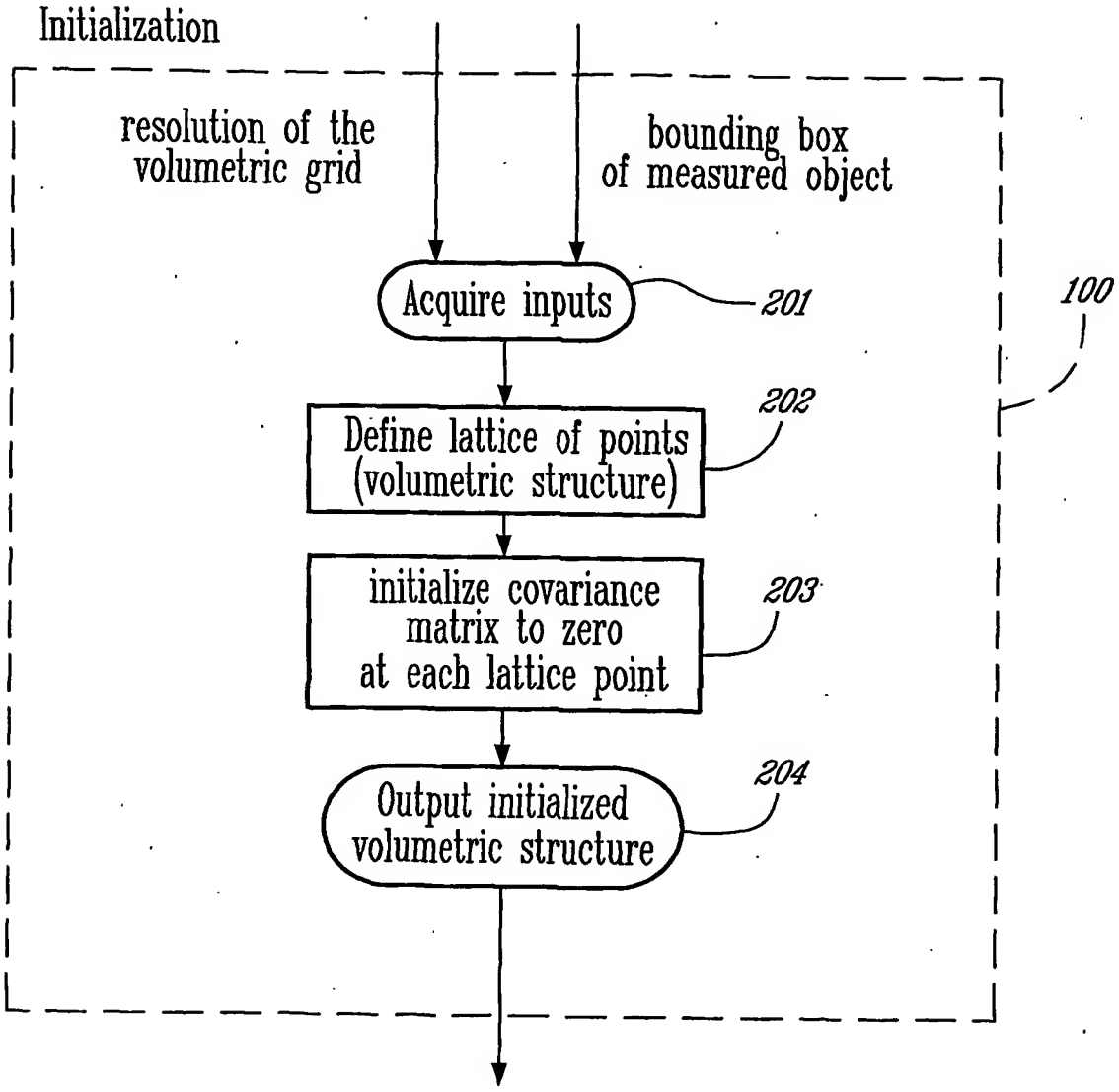
Initialization
resolution of the volumetric grid
bounding box of measured object
Acquire inputs
201
100
Define lattice of points (volumetric structure)
202
initialize covariance matrix to zero at each lattice point
203
Output initialized volumetric structure
204

Fig. 2

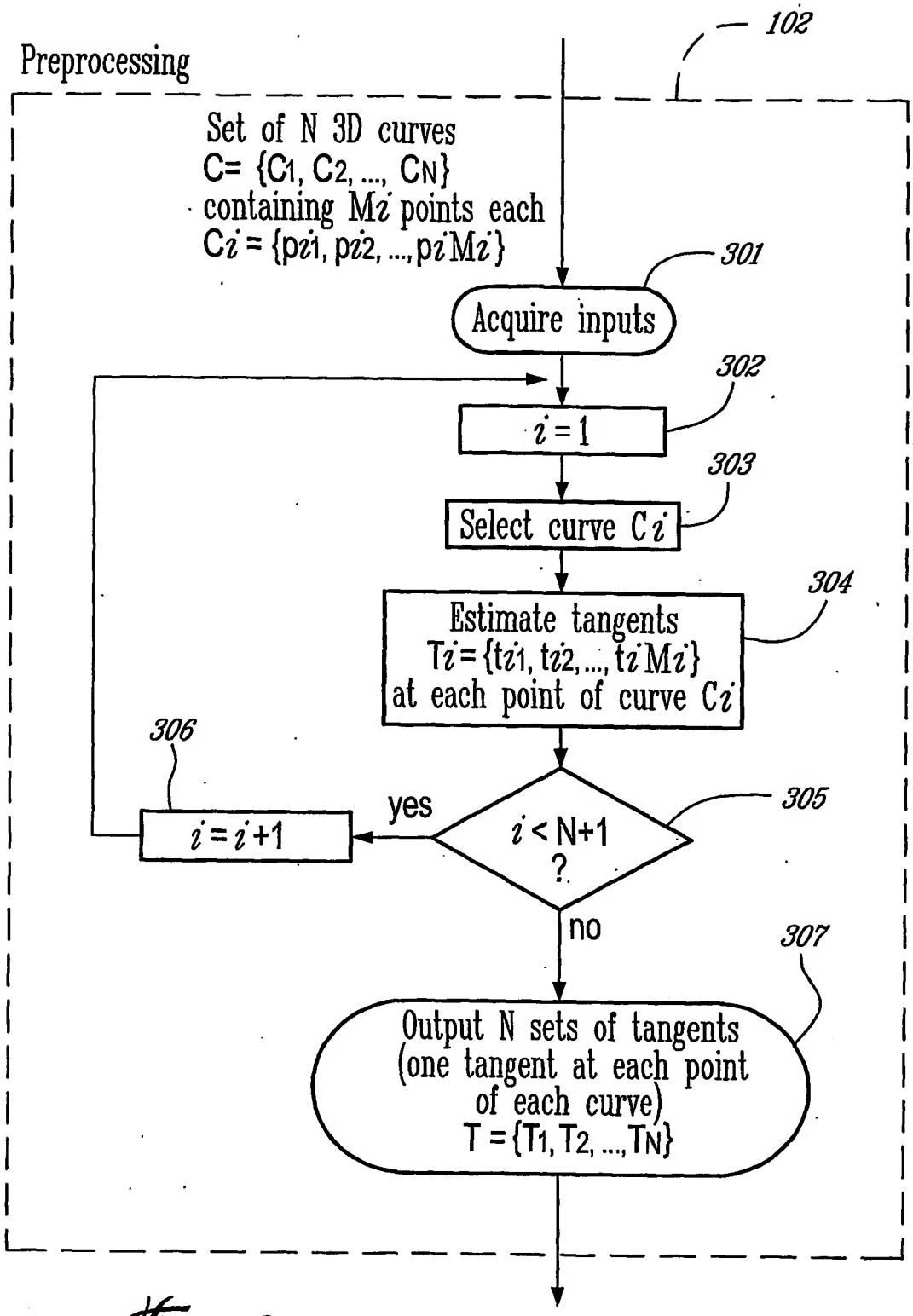
Preprocessing
102
Set of N 3D curves
C= {C1, C2, ..., CN}
containing Mi points each
Ci = {pi1, pi2, ..., piMi}
301
Acquire inputs
302
i = 1
303
Select curve Ci
304
Estimate tangents
Ti = {ti1, ti2, ..., tiMi}
at each point of curve Ci
305
i < N+1
?
yes
306
i = i+1
no
307
Output N sets of tangents
(one tangent at each point
of each curve)
T = {T1, T2, ..., TN}

Fig. 3

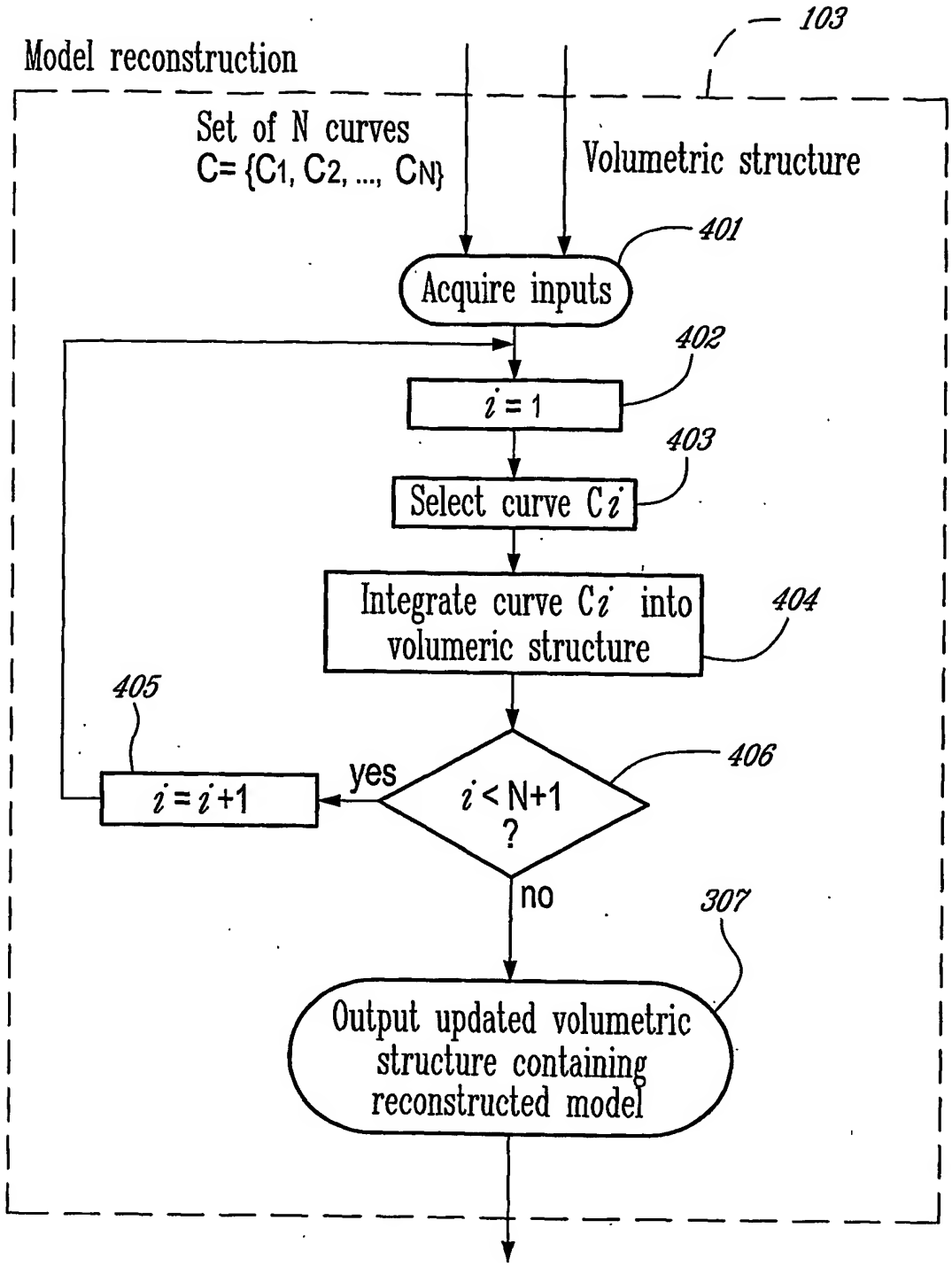
103
Model reconstruction
Set of N curves
C= {C1, C2, ..., CN}
Volumetric structure
401
Acquire inputs
402
i = 1
403
Select curve Ci
Integrate curve Ci into volumeric structure
404
405
i = i+1
yes
406
i < N+1 ?
no
307
Output updated volumetric structure containing reconstructed model

Fig. 4

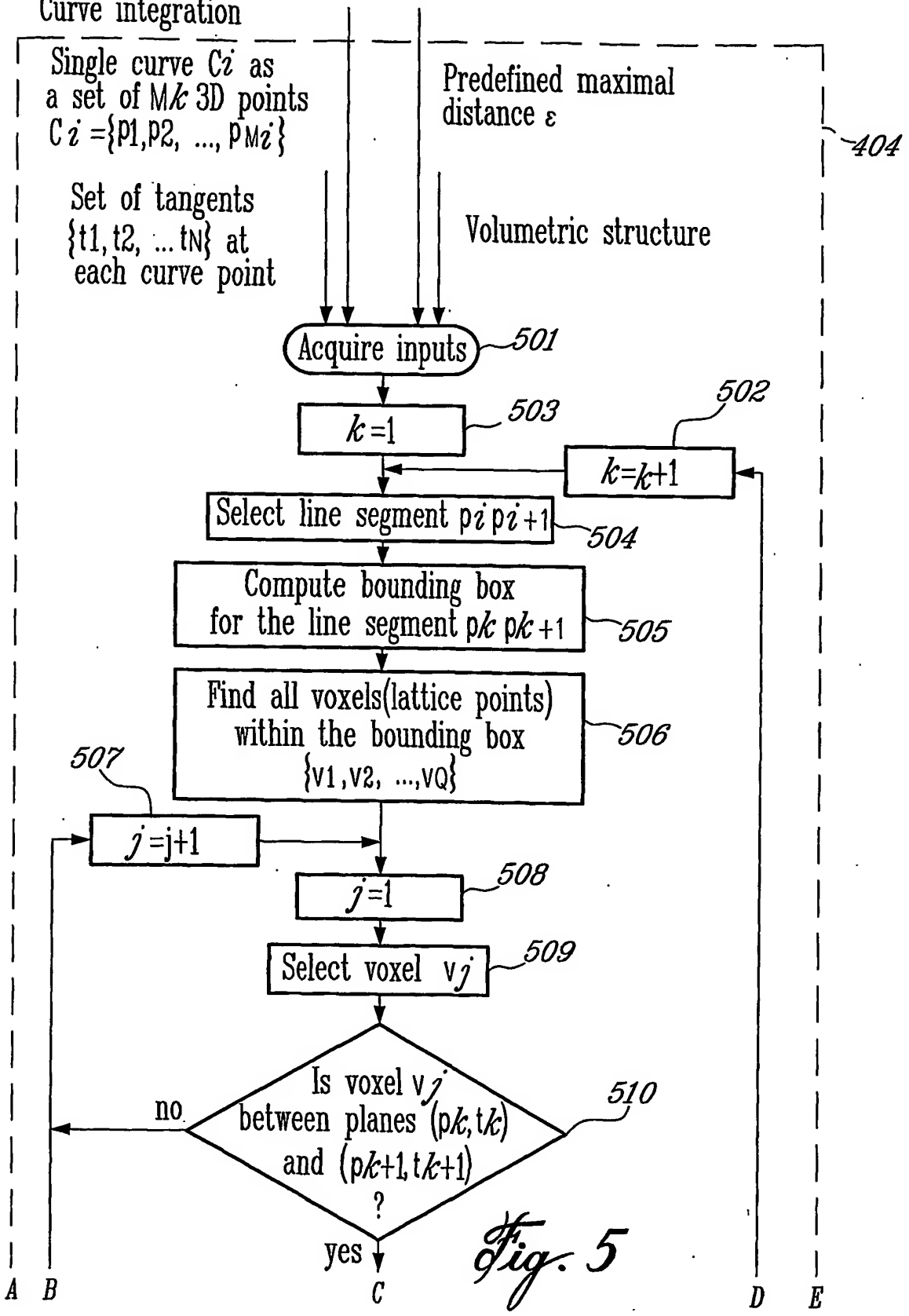
Curve integration
Single curve Ci as a set of Mk 3D points Ci ={p1,p2, ..., pMi}
Predefined maximal distance ε
Set of tangents {t1, t2, ... tN} at each curve point
Volumetric structure
404
Acquire inputs
501
k=1
503
k=k+1
502
Select line segment pi pi+1
504
Compute bounding box for the line segment pk pk+1
505
Find all voxels(lattice points) within the bounding box {v1, v2, ..., vQ}
506
507
j=j+1
j=1
508
Select voxel vj
509
Is voxel vj between planes (pk, tk) and (pk+1, tk+1) ?
510
no
yes
A
B
C
D
E

Fig. 5

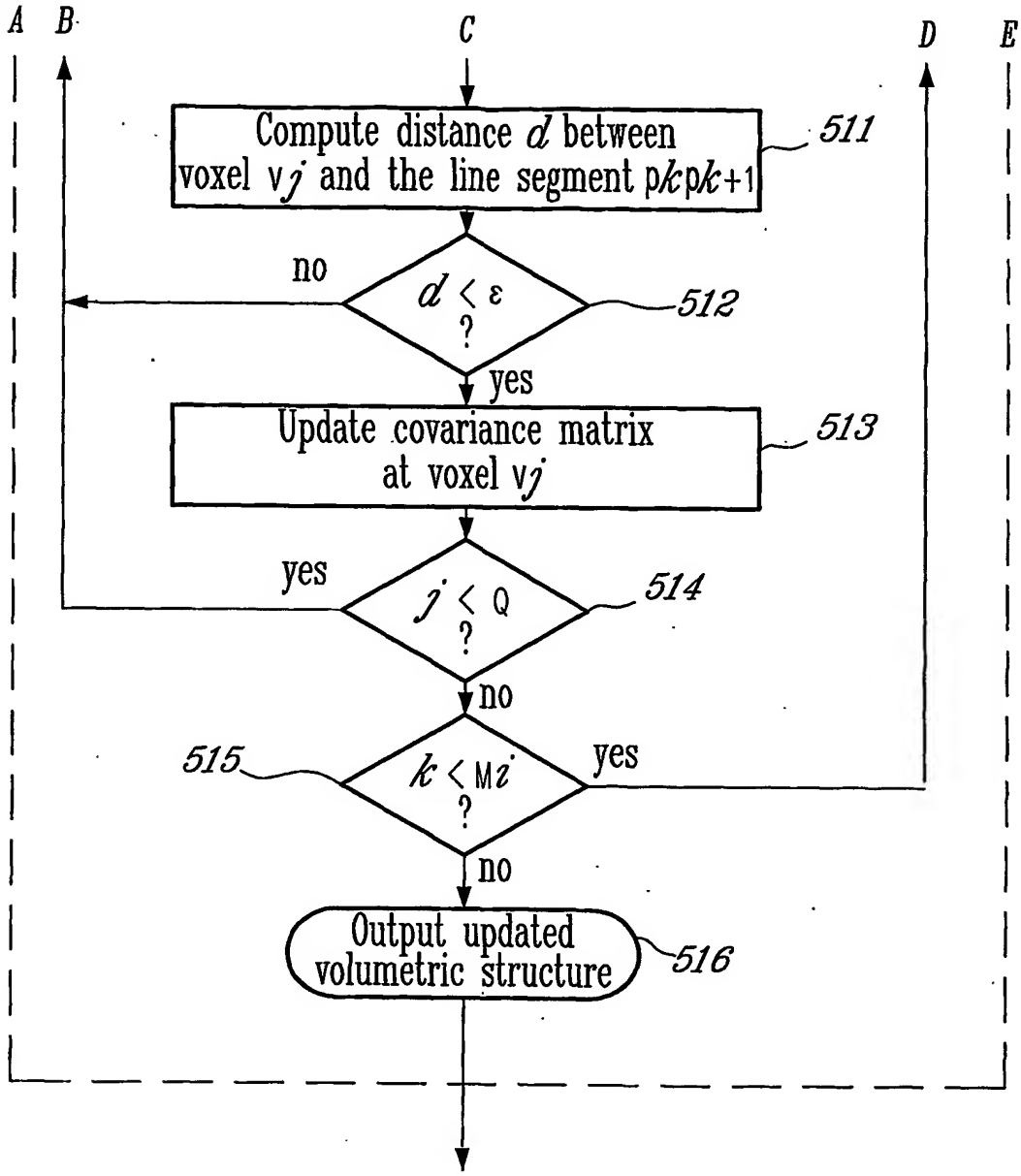

Fig. 5 (Continued)

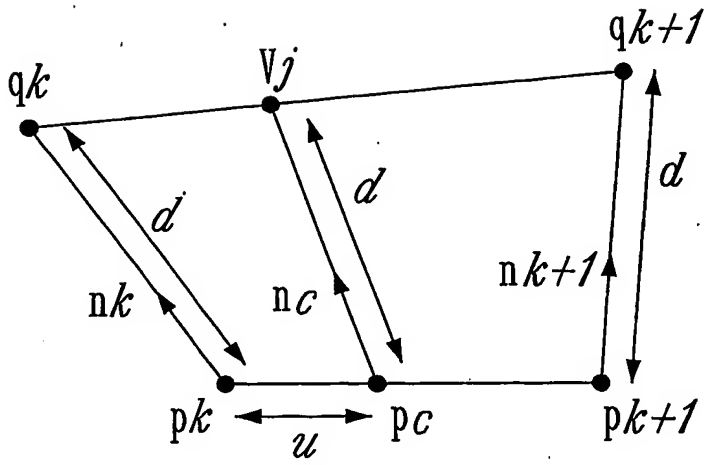

Fig. 6

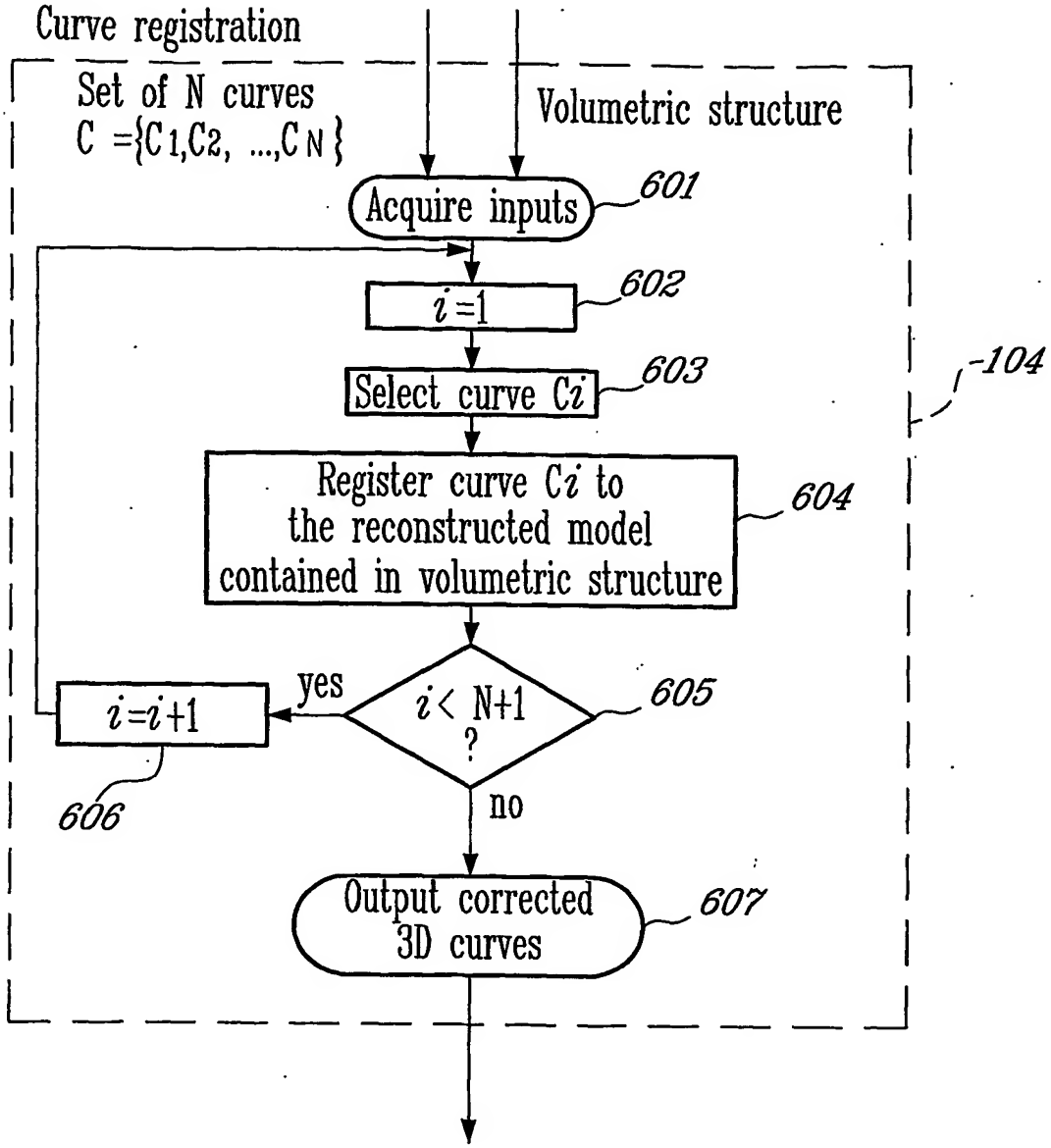
Curve registration
Set of N curves
C ={C1,C2, ...,CN}
Volumetric structure
Acquire inputs
601
i=1
602
Select curve Ci
603
104
Register curve Ci to
the reconstructed model
contained in volumetric structure
604
i< N+1
?
605
yes
i=i+1
606
no
Output corrected
3D curves
607

Fig. 7

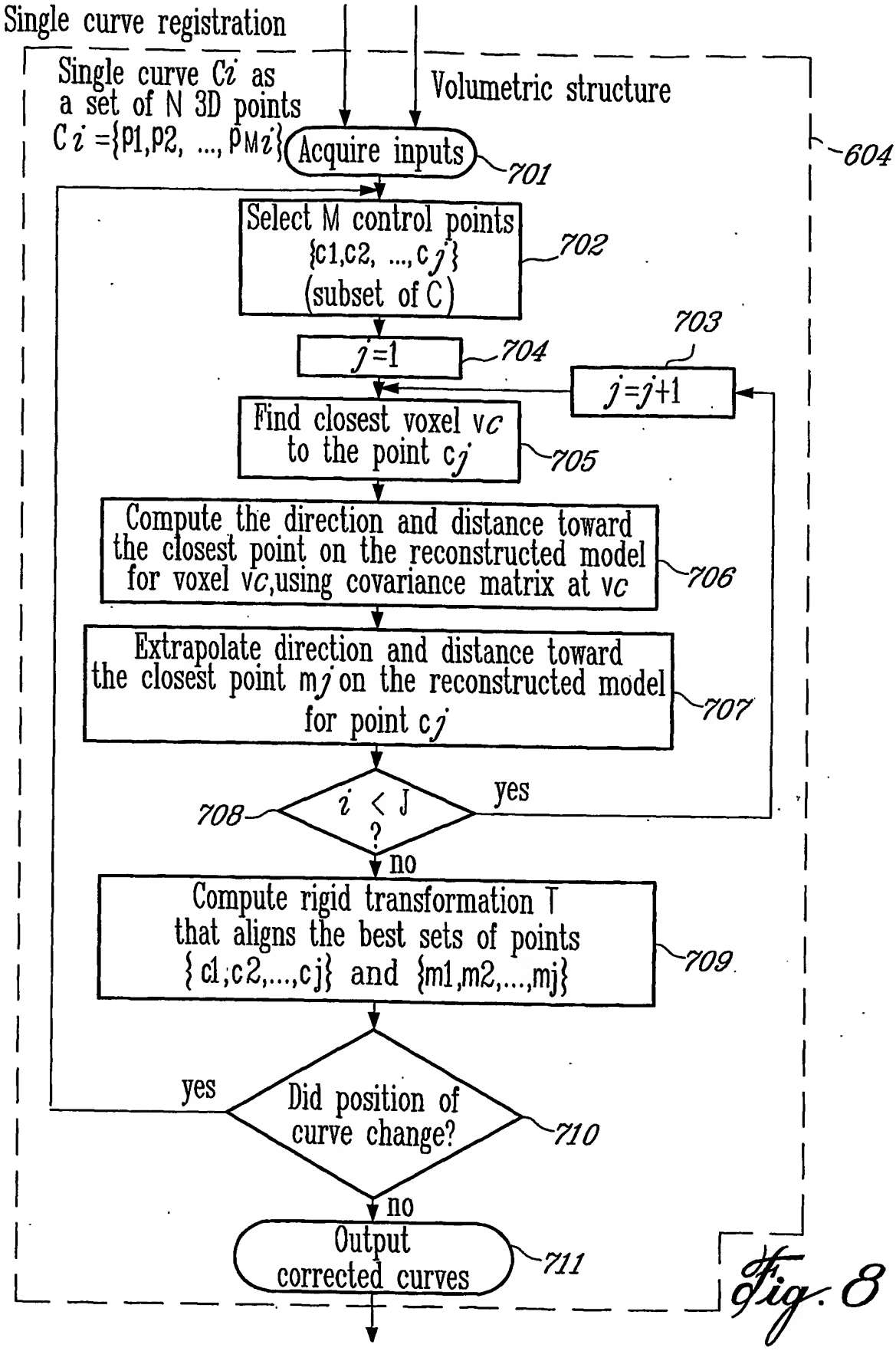
Single curve registration
Single curve Ci as a set of N 3D points
Ci ={p1,p2, ..., pMi}
Volumetric structure
Acquire inputs
701
604
Select M control points {c1,c2, ...,cj} (subset of C)
702
703
j=1
704
j=j+1
Find closest voxel vc to the point cj
705
Compute the direction and distance toward the closest point on the reconstructed model for voxel vc,using covariance matrix at vc
706
Extrapolate direction and distance toward the closest point mj on the reconstructed model for point cj
707
i < J ?
708
yes
no
Compute rigid transformation T that aligns the best sets of points {c1;c2,...,cj} and {m1,m2,...,mj}
709
Did position of curve change?
710
yes
no
Output corrected curves
711

Fig. 8

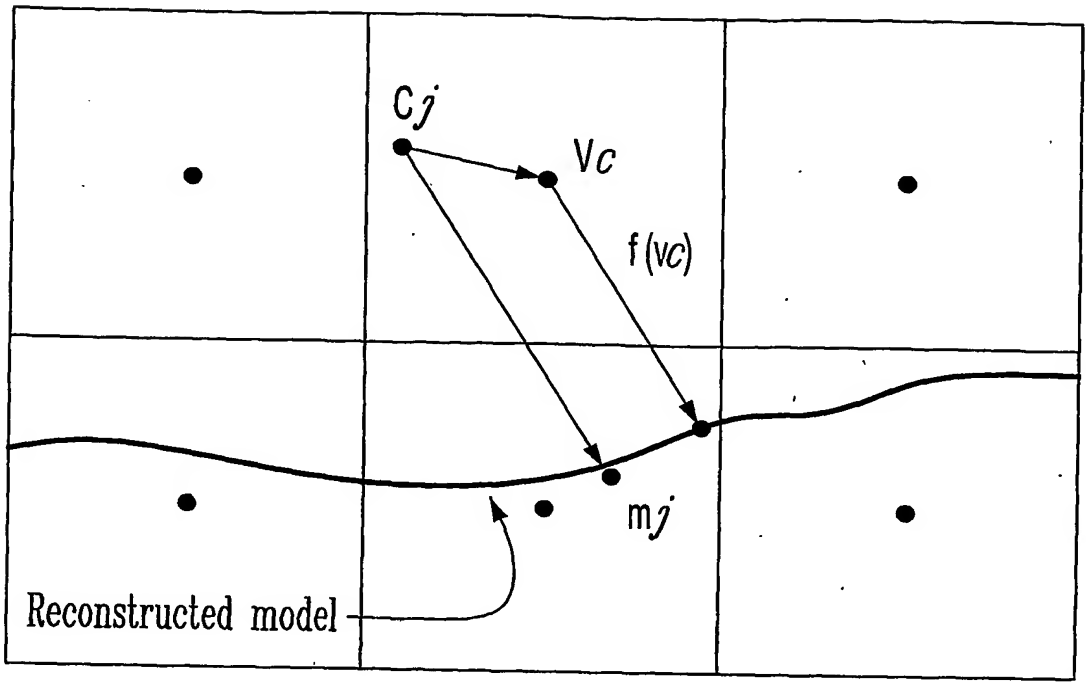

Fig. 9

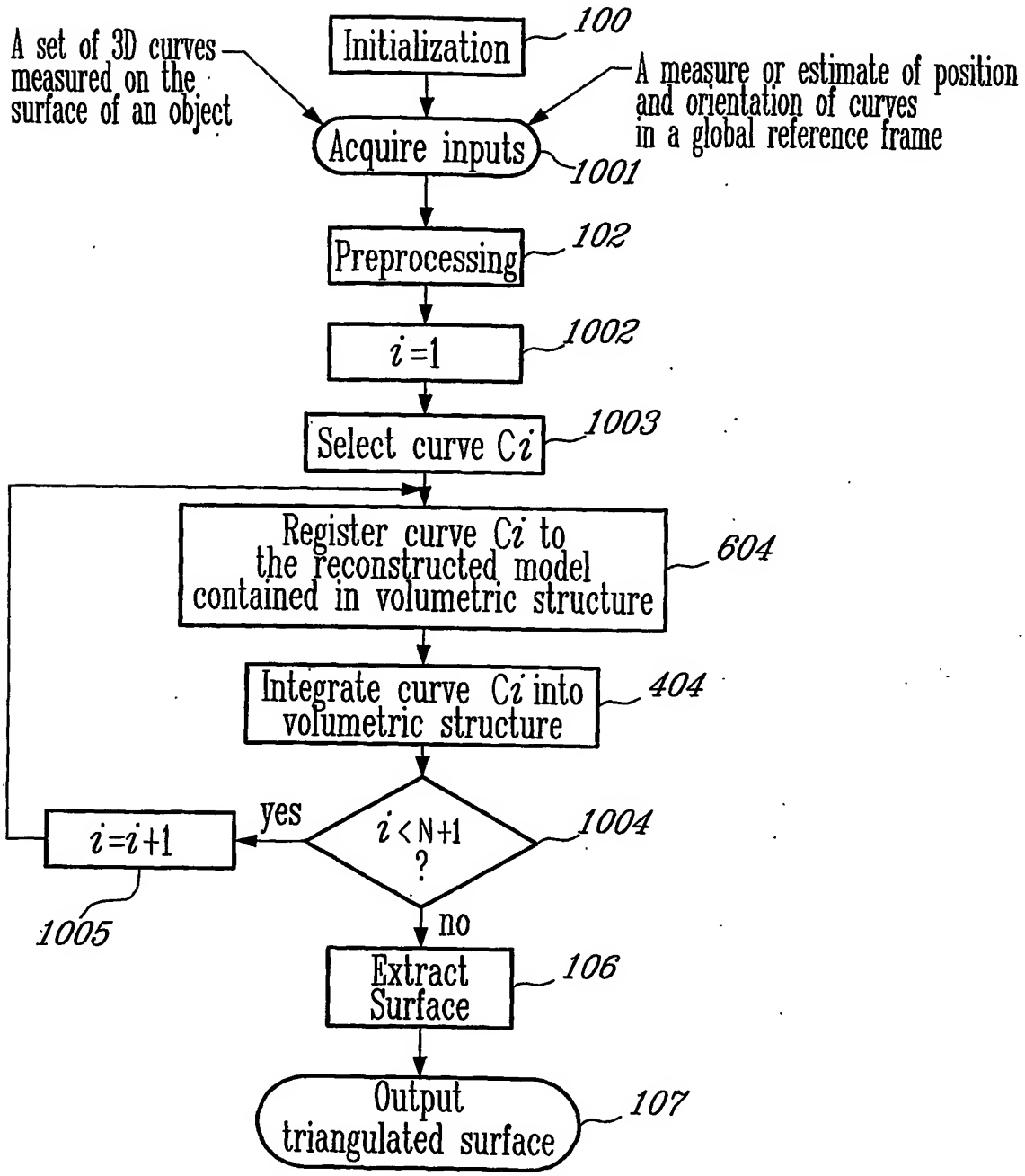
A set of 3D curves measured on the surface of an object
Initialization
100
A measure or estimate of position and orientation of curves in a global reference frame
Acquire inputs
1001
Preprocessing
102
i=1
1002
Select curve Ci
1003
Register curve Ci to the reconstructed model contained in volumetric structure
604
Integrate curve Ci into volumetric structure
404
i<N+1 ?
1004
yes
i=i+1
1005
no
Extract Surface
106
Output triangulated surface
107

Fig. 10

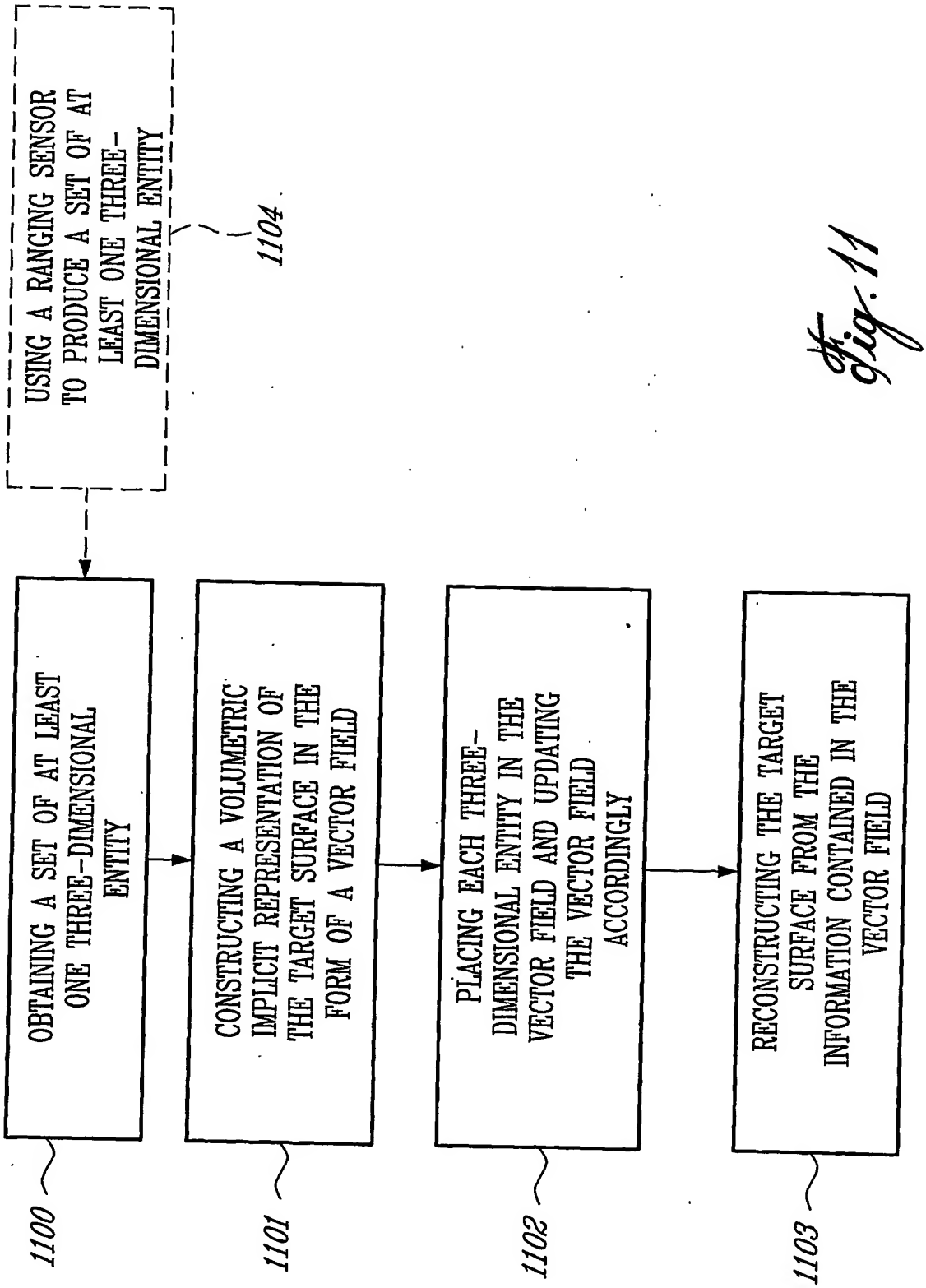
USING A RANGING SENSOR TO PRODUCE A SET OF AT LEAST ONE THREE-DIMENSIONAL ENTITY
1104
OBTAINING A SET OF AT LEAST ONE THREE-DIMENSIONAL ENTITY
1100
CONSTRUCTING A VOLUMETRIC IMPLICIT REPRESENTATION OF THE TARGET SURFACE IN THE FORM OF A VECTOR FIELD
1101
PLACING EACH THREE-DIMENSIONAL ENTITY IN THE VECTOR FIELD AND UPDATING THE VECTOR FIELD ACCORDINGLY
1102
RECONSTRUCTING THE TARGET SURFACE FROM THE INFORMATION CONTAINED IN THE VECTOR FIELD
1103

Fig. 11

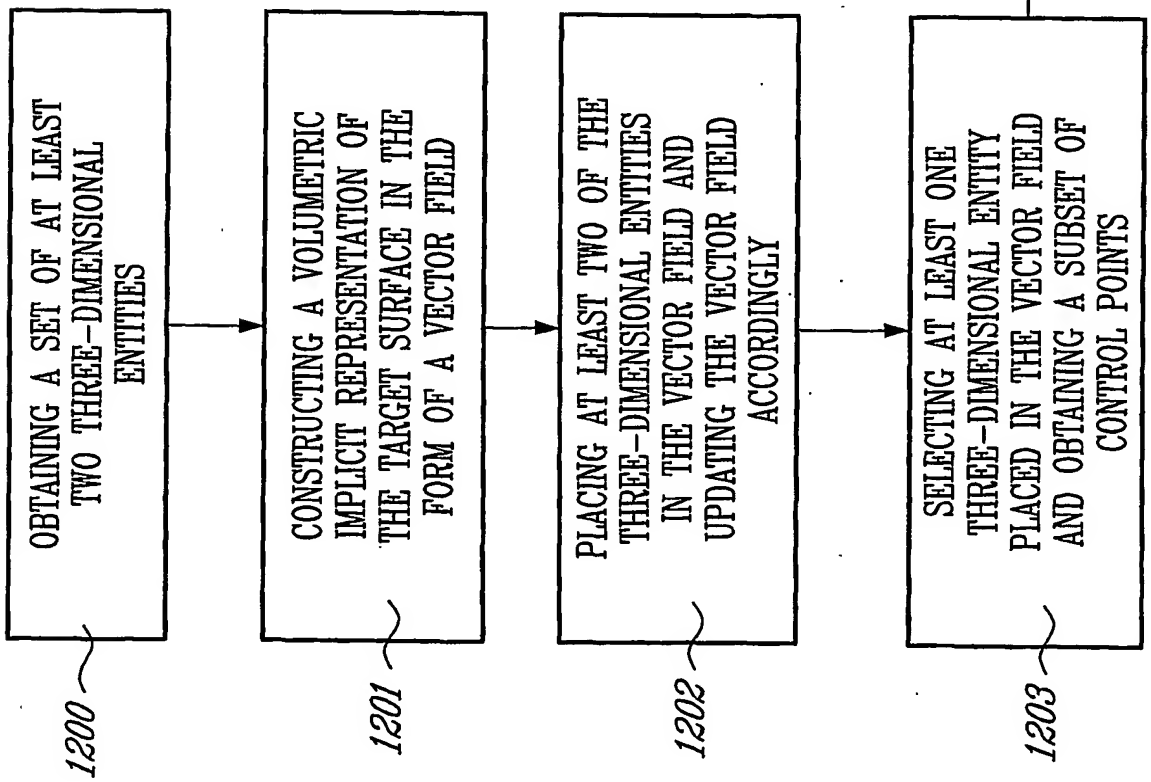
OBTAINING A SET OF AT LEAST TWO THREE-DIMENSIONAL ENTITIES
1200
CONSTRUCTING A VOLUMETRIC IMPLICIT REPRESENTATION OF THE TARGET SURFACE IN THE FORM OF A VECTOR FIELD
1201
PLACING AT LEAST TWO OF THE THREE-DIMENSIONAL ENTITIES IN THE VECTOR FIELD AND UPDATING THE VECTOR FIELD ACCORDINGLY
1202
SELECTING AT LEAST ONE THREE-DIMENSIONAL ENTITY PLACED IN THE VECTOR FIELD AND OBTAINING A SUBSET OF CONTROL POINTS
1203
FOR EACH CONTROL POINT, COMPUTING A COST FUNCTION
1204
FOR EACH SELECTED ENTITY, COMPUTING A NEW POSITION
1205
PLACING EACH SELECTED ENTITY IN THE VECTOR FIELD AT ITS NEWLY COMPUTED POSITION AND UPDATING THE VECTOR FIELD ACCORDINGLY
1206

Fig. 12

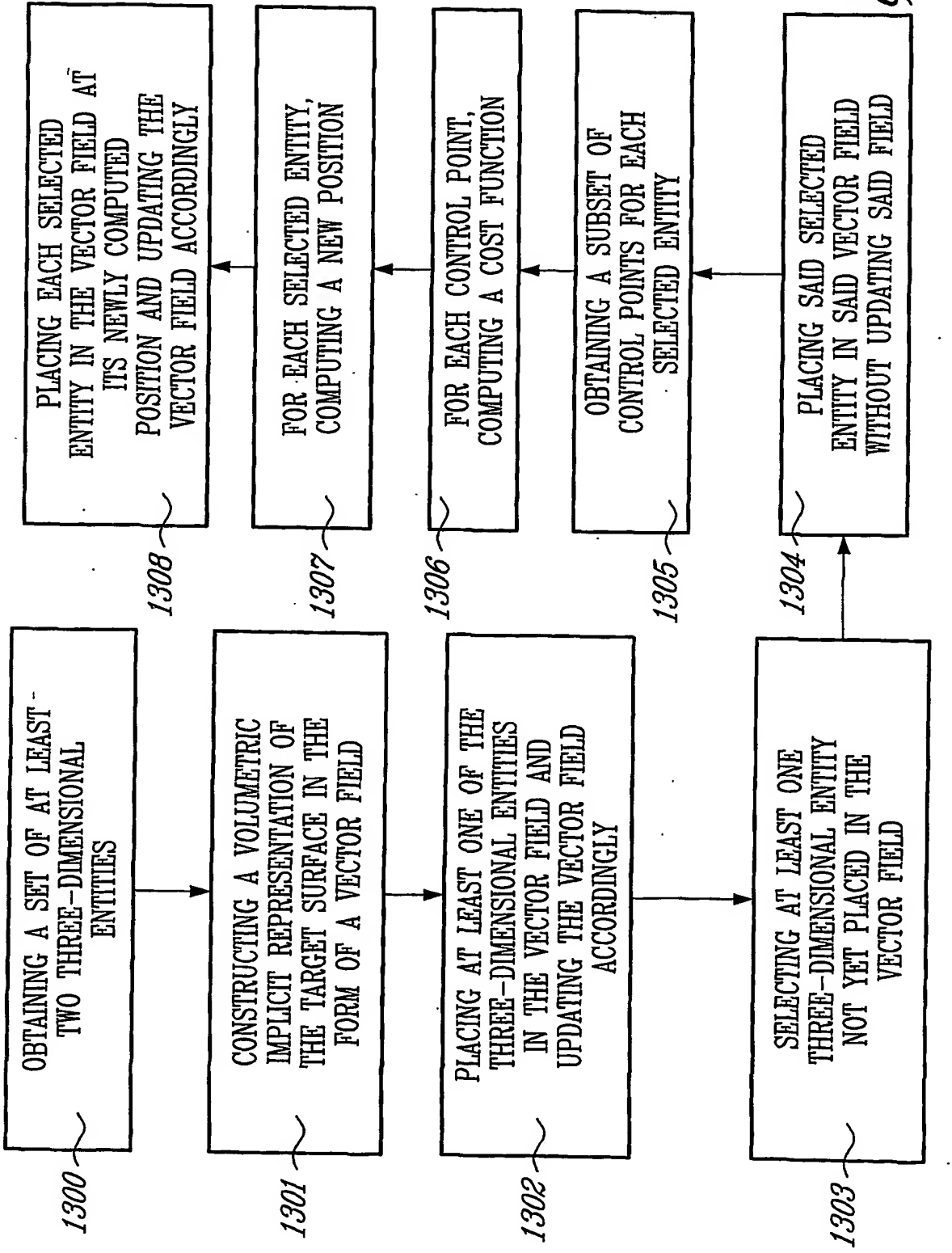
OBTAINING A SET OF AT LEAST TWO THREE-DIMENSIONAL ENTITIES
1300
CONSTRUCTING A VOLUMETRIC IMPLICIT REPRESENTATION OF THE TARGET SURFACE IN THE FORM OF A VECTOR FIELD
1301
PLACING AT LEAST ONE OF THE THREE-DIMENSIONAL ENTITIES IN THE VECTOR FIELD AND UPDATING THE VECTOR FIELD ACCORDINGLY
1302
SELECTING AT LEAST ONE THREE-DIMENSIONAL ENTITY NOT YET PLACED IN THE VECTOR FIELD
1303
PLACING SAID SELECTED ENTITY IN SAID VECTOR FIELD WITHOUT UPDATING SAID FIELD
1304
OBTAINING A SUBSET OF CONTROL POINTS FOR EACH SELECTED ENTITY
1305
FOR EACH CONTROL POINT, COMPUTING A COST FUNCTION
1306
FOR EACH SELECTED ENTITY, COMPUTING A NEW POSITION
1307
PLACING EACH SELECTED ENTITY IN THE VECTOR FIELD AT ITS NEWLY COMPUTED POSITION AND UPDATING THE VECTOR FIELD ACCORDINGLY
1308

Fig. 13

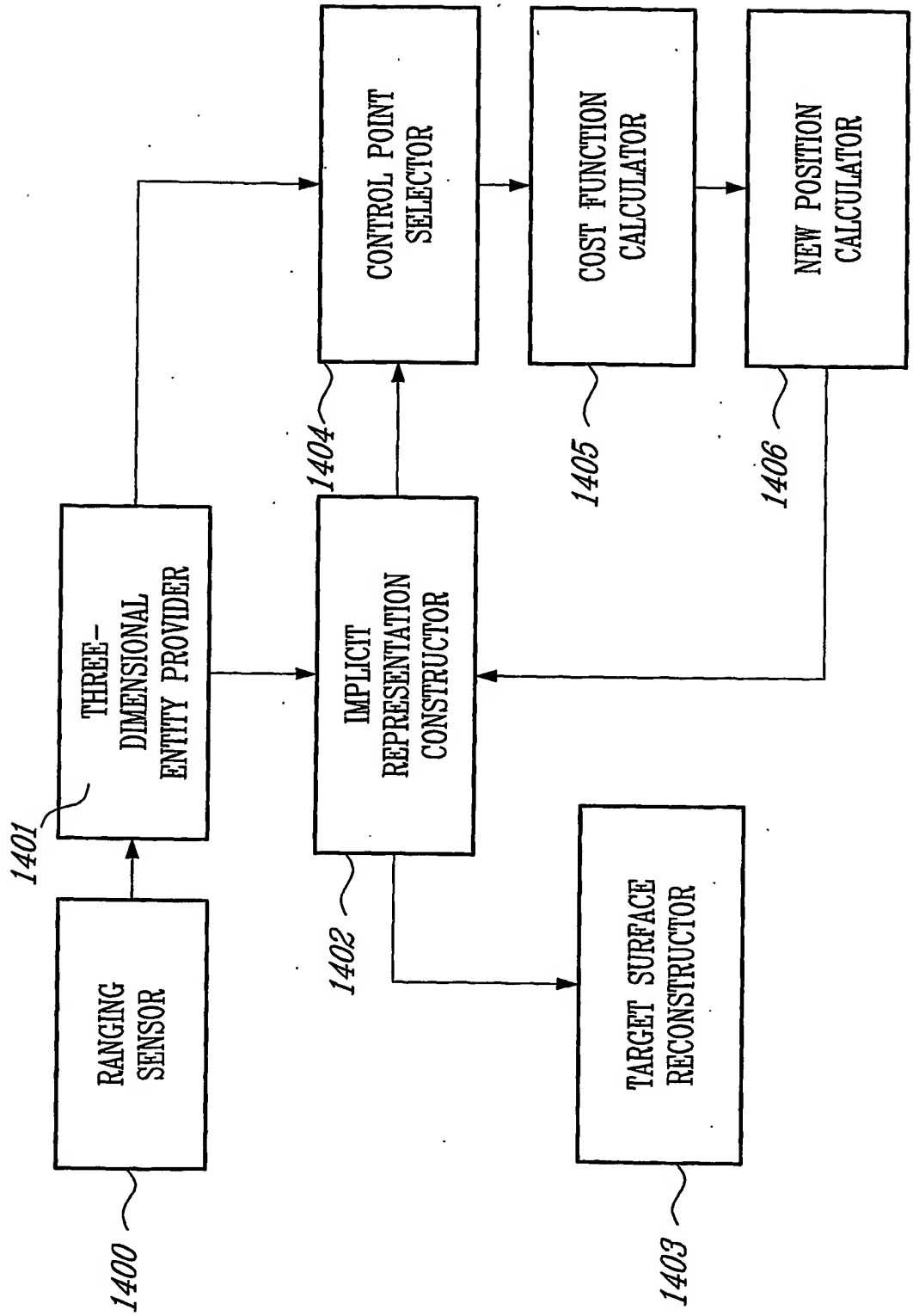
RANGING SENSOR
THREE-DIMENSIONAL ENTITY PROVIDER
IMPLICIT REPRESENTATION CONSTRUCTOR
TARGET SURFACE RECONSTRUCTOR
CONTROL POINT SELECTOR
COST FUNCTION CALCULATOR
NEW POSITION CALCULATOR
1400
1401
1402
1403
1404
1405
1406

fig. 14